

Energy and Environmental Analysis, Inc.



Combined Heat and Power California Market Assessment

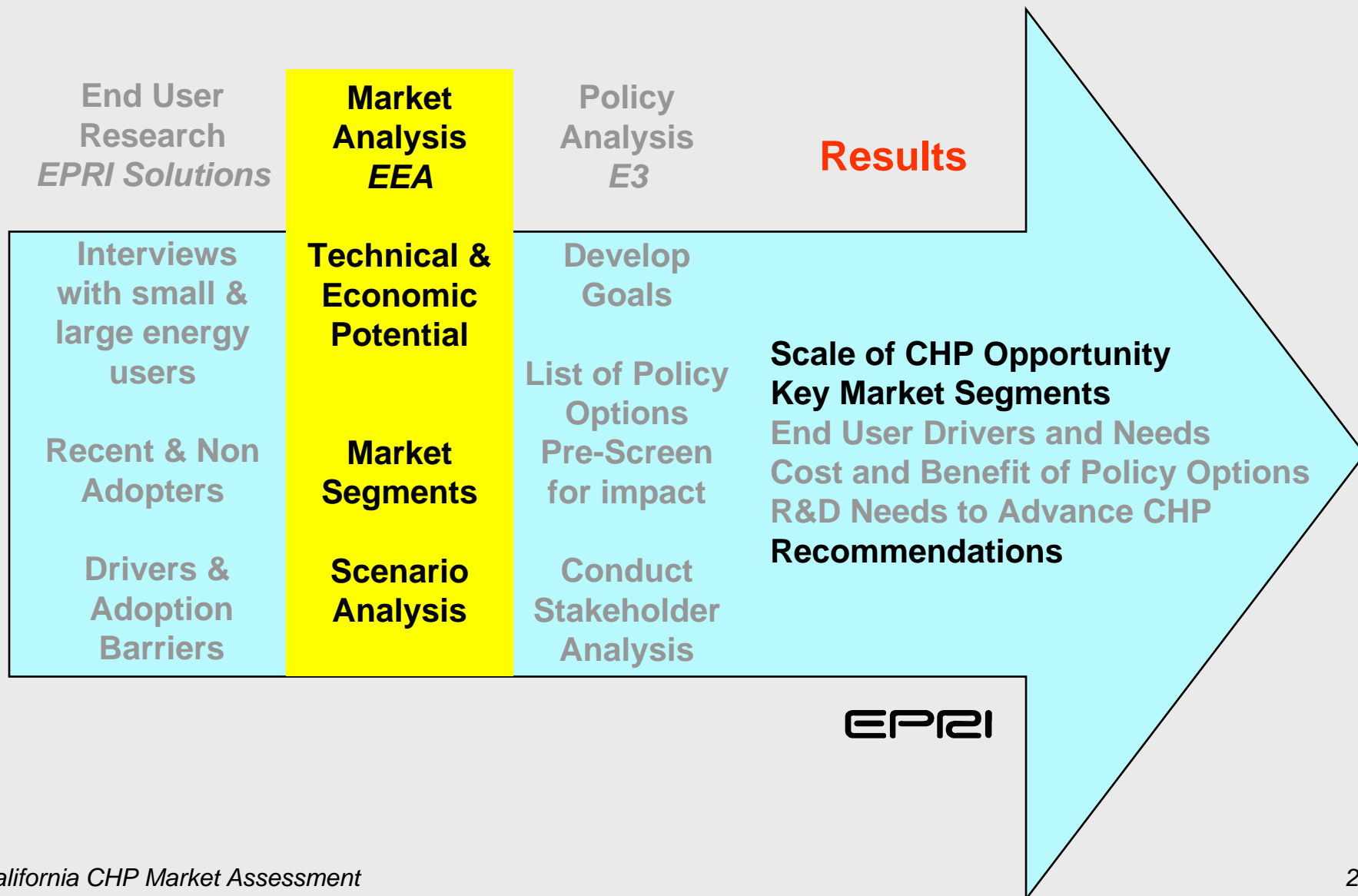
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Anne Hampson**

**Presented to:
California Energy Commission
April 28, 2005**



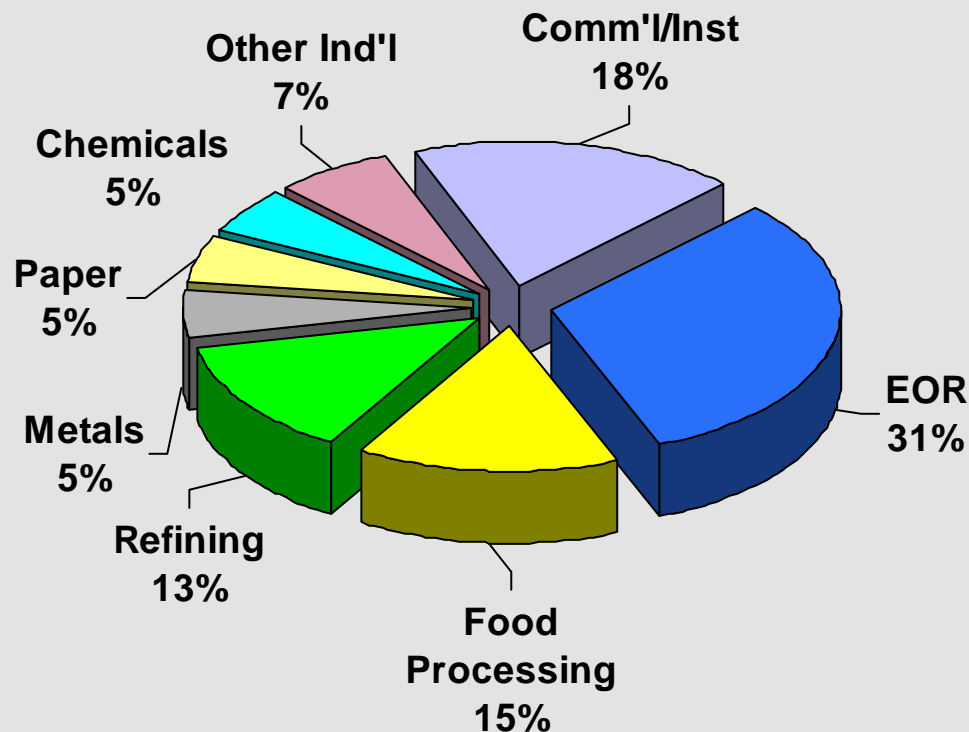


Project Research Approach





CHP in California Today

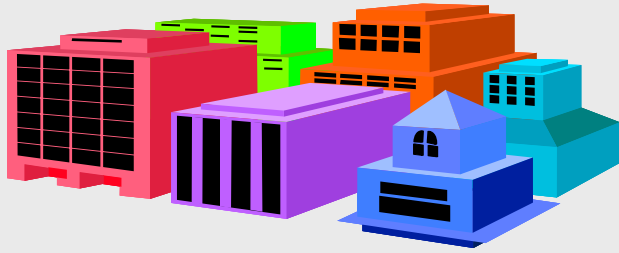


- Highest capacity in the U.S. – 9,119 MW
- Oil Recovery largest single market sector
- Concentrated in 5 process industries
- 782 sites
- 17% < 5 MW
- 52% > 50 MW



Competitive Decision for Implementing CHP

- Electric and thermal load characteristics of commercial, industrial, and institutional facilities in the State
- Natural gas and electricity prices – *spark spread*
- Equipment cost and performance by application
- Incentive payments, if any, to the CHP user
- Customer value decisions – payback, risk, management focus



Applications Databases

Output: Technical Market Potential
by Size, Application and State

Analytical Framework



Microturbine



Turbine

Technology Competition Analysis

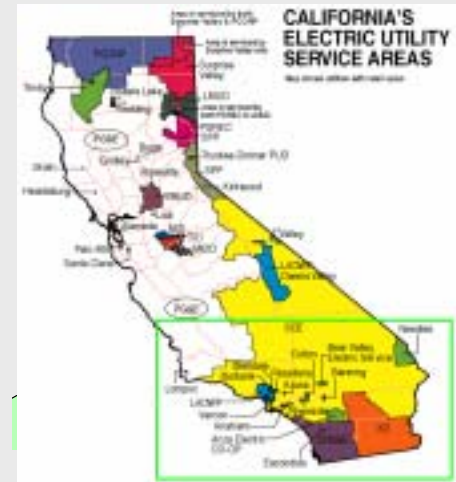


Recip. Engine

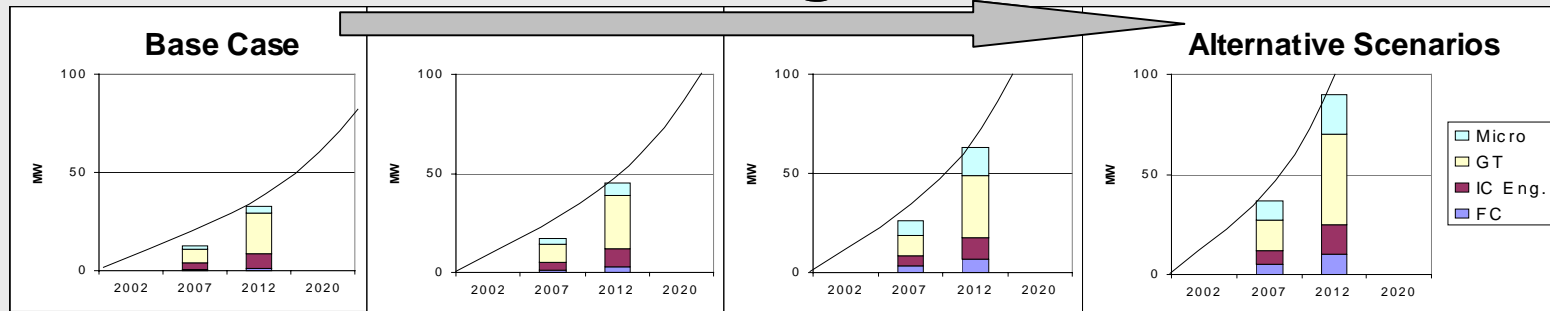


Fuel Cell

Output: Technology Competition
by DER application, net power costs,
emissions profiles



DER Market Deployment Scenarios





Technical Potential for Additional CHP in California

- Technical Market Potential – sites with thermal and electric loads that could support CHP
 - Continuous baseload operation (if possible)
 - High utilization of thermal energy
- Technical Potential at existing facilities (2005) based on analysis of commercial and industrial facilities databases
- Technical Potential at new facilities (2005 – 2020) based on annual sectoral growth rates applied to existing facilities

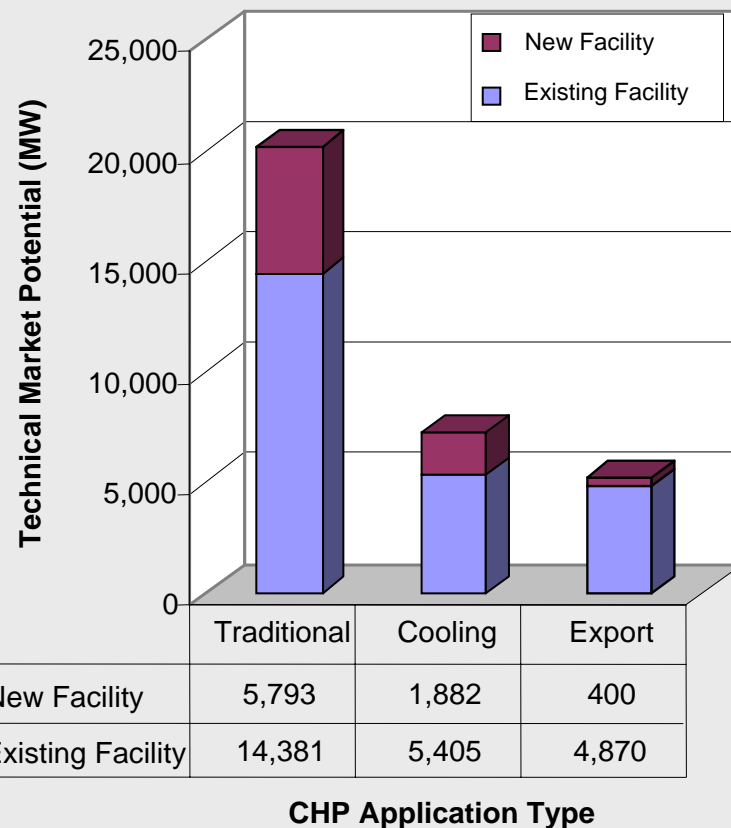
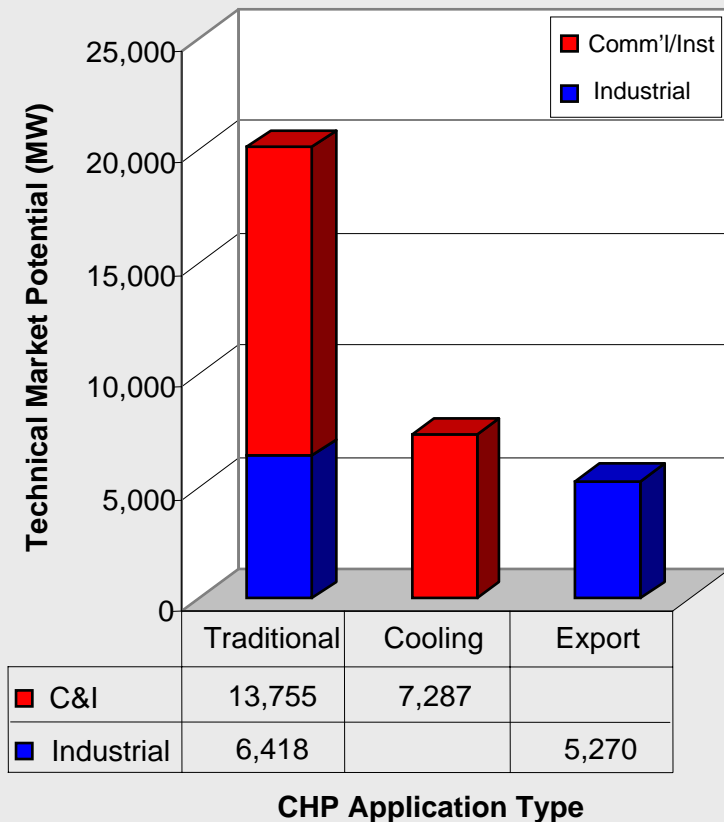


Technical Potential for Additional CHP in California

- Traditional steam/hot water CHP
 - High load factor (>7500 hours)
 - Low load factor (4500 hours)
- Combined cooling, heating and power
 - Additional applications
 - Incremental applications
- Export power market
 - Industrial sites with excess steam load



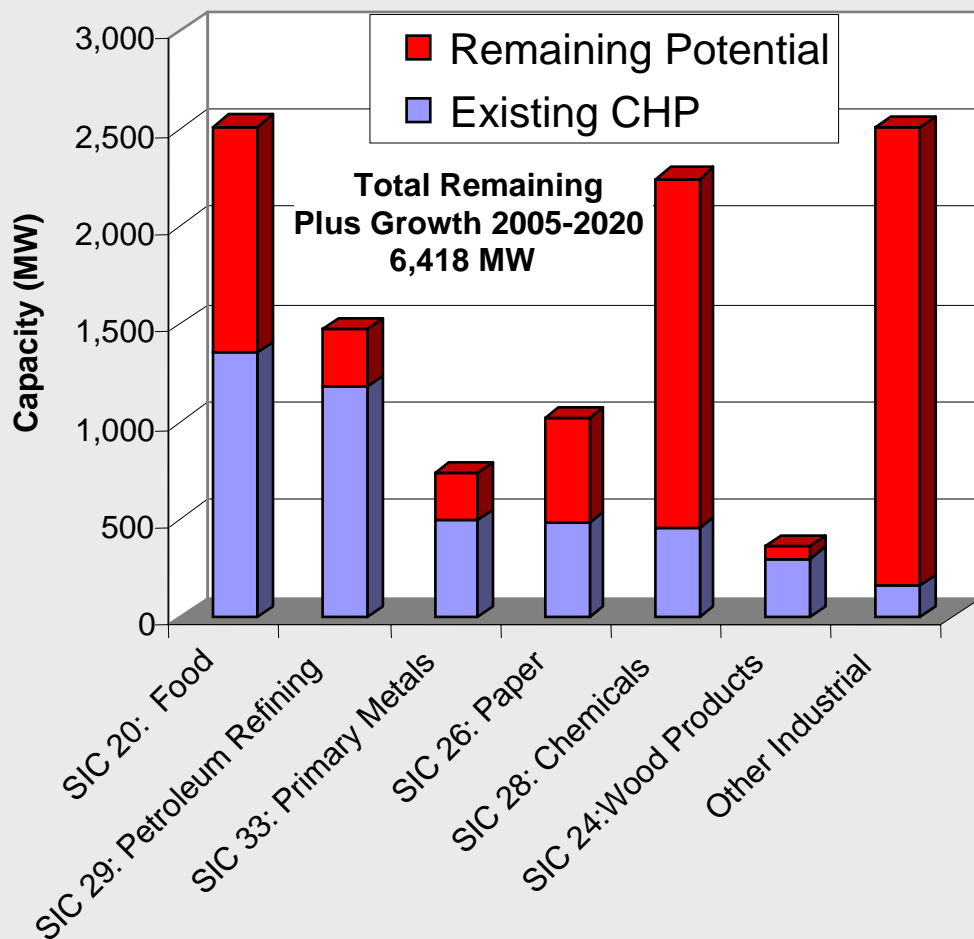
Total Remaining Technical Market Potential





Traditional CHP – Industrial Sector

Industrial CHP Technical Potential

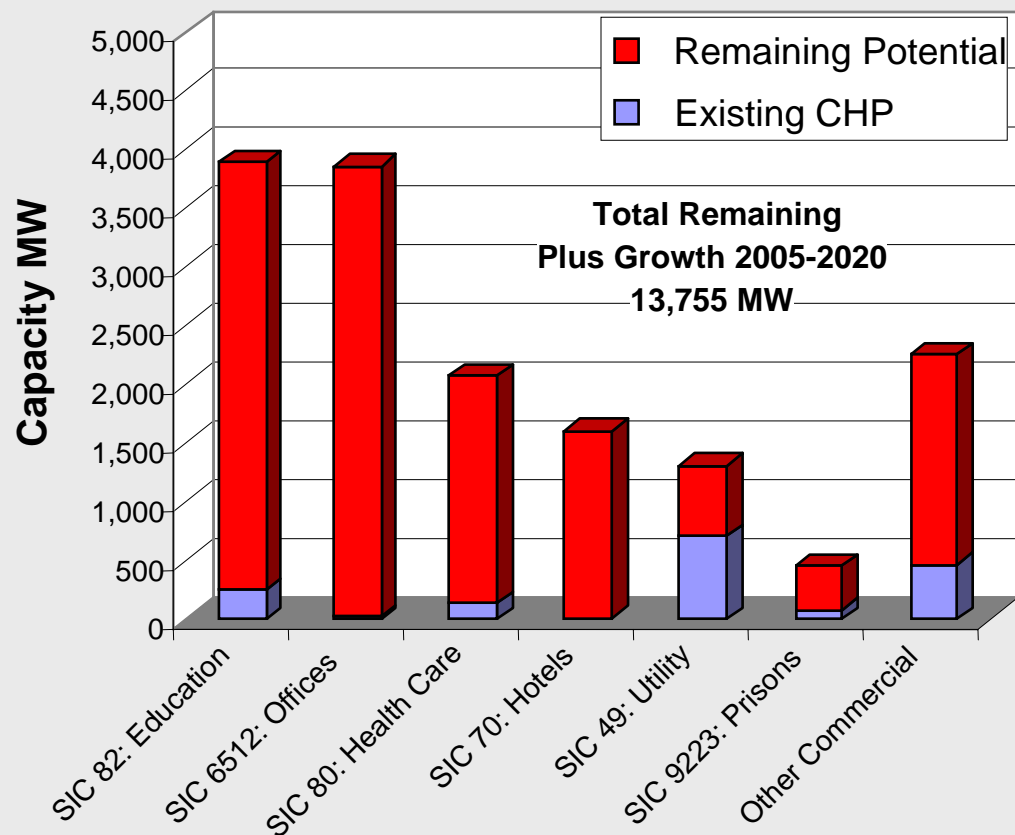


- Onsite use of electric and thermal energy
- 96% of existing CHP and 67% of remaining potential concentrated in 6 major industries
- Average 60% market saturation in these industries



Traditional CHP – Commercial and Institutional Sector

Commercial/Institutional Technical Potential



- Commercial/ Institutional sector makes up 2/3rds of remaining tech potential
- Top applications are education, offices, health care, and hotels



Additional Markets – Technical Potential

- CCHP markets – 7,287 MW (4,122 MW net)
 - Incremental load in traditional markets – subset of traditional CHP market but cooling allows larger capacity systems to be installed – total potential 4,444 MW (additive component 1,280 MW)
 - Cooling specific applications (not part of traditional CHP market) – 2,843 MW in post offices, airports, movie theaters, big-box retail, food sales, and restaurants
 - Additional 10-18% effective electric capacity due to reduction in electric chiller use
- Export Market – 5,270 MW
 - Top 100 industrial facilities in the state evaluated
 - Handful of very large refineries, chemical plants, and food processors
 - Almost all from existing facilities



General Base Case Description

- General consistency of rate forecasts with IEPR2003 assumptions adjusted for current market conditions
 - Continuation of high natural gas prices
 - Wellhead price declines early followed by prices increasing in real terms through 2020
 - Electric rate stability
 - Declining prices for IOUs in first 5 years
 - Constant real delivery costs after 2010
 - Generation prices rising with gas prices after 2010
- Incremental technology improvements
 - EPAG program targets not included
- 2007 emissions standards accelerated in the South
 - 0.07 lbs/MWh NOx limit required in South in 2005
 - Emissions limit schedules unchanged in the North
- SGIP Program extended to 2014
- No Power Export – all power used on-site



Technical Market Potential and Base Case Market Penetration – Summary

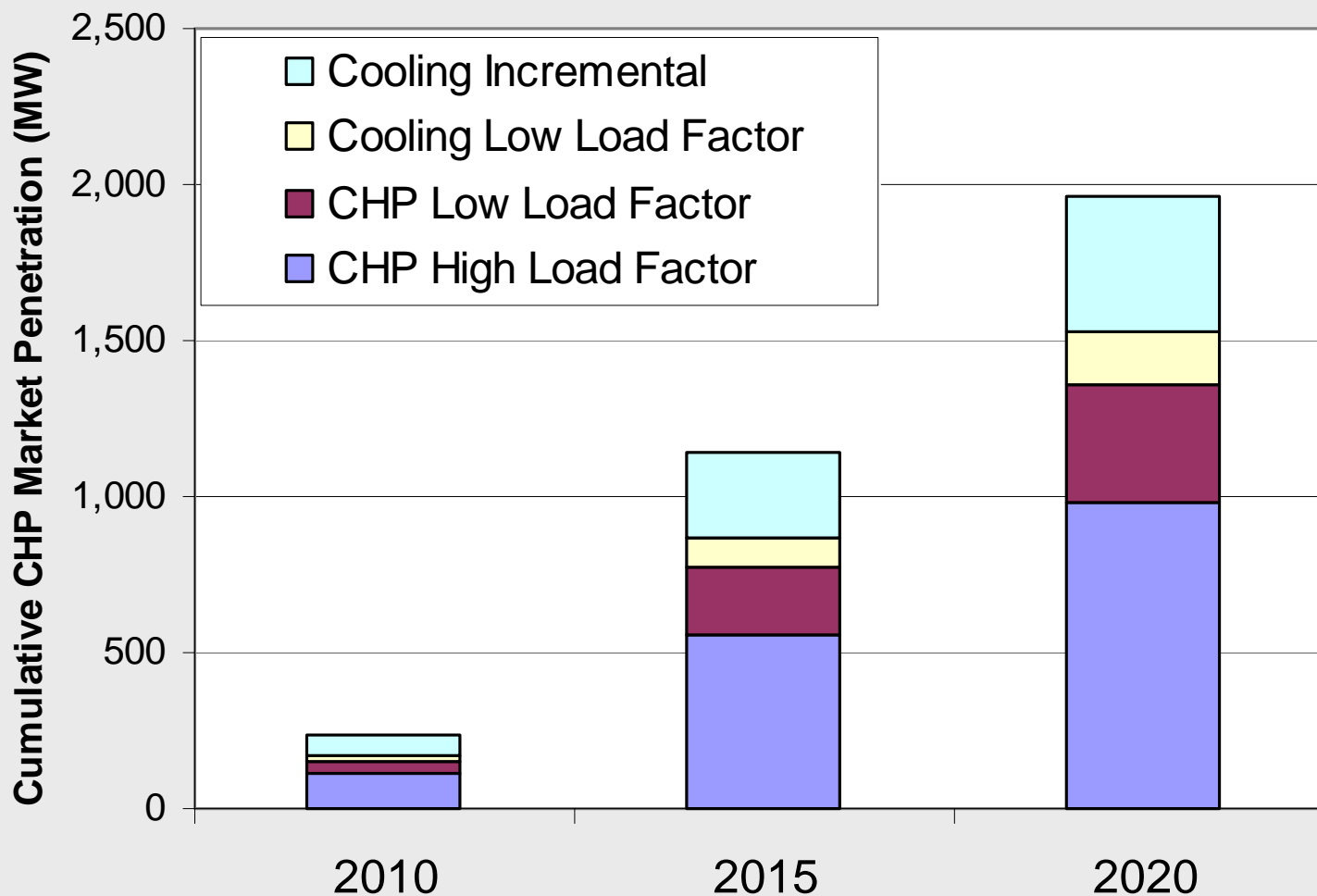
	Technical Market Potential			Cumulative Market Pen. 2005-2020 MW	Penetration Share
	Existing Facilities 2005 MW	New Facilities 2005-2020 MW	Total Market Potential MW		
Traditional CHP					
High Load Factor	10,819	3,743	14,562	1,289	8.9%
Low Load Factor	3,561	2,050	5,611	383	6.8%
Traditional Total	14,381	5,793	20,174	1,673	8.3%
Cooling CHP					
Cooling Specific Markets	1,846	997	2,843	167	5.9%
Incremental Markets*	3,559	884	4,443	439	9.9%
Cooling Total	5,405	1,881	7,286	606	8.3%
Grand Total	17,252	7,045	24,296	1,967	8.1%

* Only additive market impact (29%) added to grand total

- Existing potential based on analysis of commercial and industrial facility databases
- New markets based on average annual sectoral growth rates in last five years of California Gross State Product



Base Case Results – by Market





Base Case: 2020 Cumulative Market Penetration - All Markets by Region and Utility

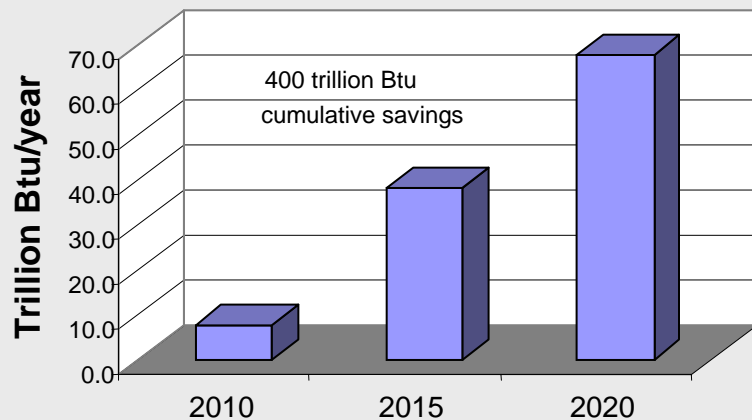
Region	Utility	50-500 kW MW	500kW-1,000kW MW	1-5 MW MW	5-20 MW MW	>20 MW MW	All Sizes MW
North	PG&E	167	239	286	72	74	839
	SMUD	8	14	18	5	0	45
	Other North	2	3	3	0	0	8
North Total		178	256	306	77	74	891
South	LADWP	7	5	14	5	15	47
	SCE	155	181	318	60	133	847
	SDG&E	28	39	63	6	18	155
	Other South	6	6	11	4	0	27
South Total		196	231	406	76	167	1,075
Grand Total		373	487	713	153	241	1,966

- Market potential split evenly in the North and South
- >5 MW market penetration limited due to smaller remaining technical potential
- SGIP support in the smaller sizes allows small systems to be competitive
- 6-8% of technical potential in the smaller sizes, 22% of the >20 MW technical potential penetrates the market

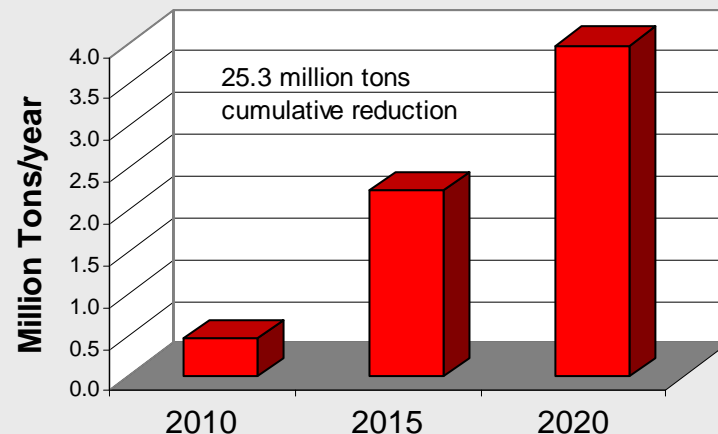


Base Case: Benefit Measures

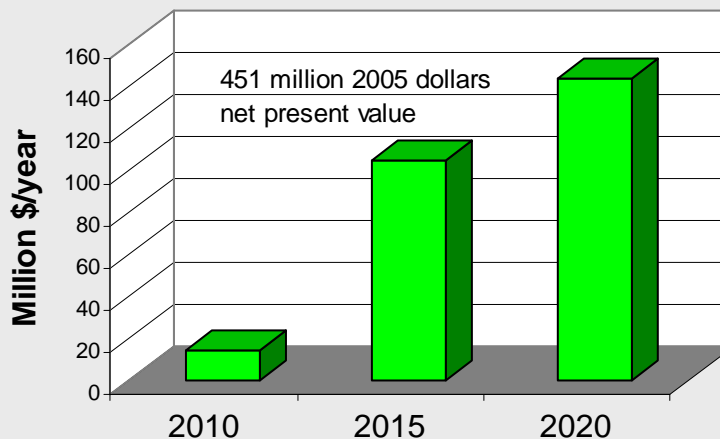
Energy Savings



CO2 Reduction



Net Customer Savings





Base Case Observations

- Large industrial export potential not considered in the base case
- Engines and small gas turbines do not meet South Coast 2007 phased emissions standards until 2010 based on base case assumptions
- LADWP is the most restrictive market for CHP due to effectively higher standby costs
- 2005-2015 SGIP eligible market penetration equal to 678 MW – 512 MW in systems <1 MW; the rest for payments on the first 1 MW for systems 1-5 MW – \$407 million total incentives paid
- 606 MW in CCHP configuration – saving an additional 70-90 MW of peak electric capacity by displacement of electrically driven air conditioning

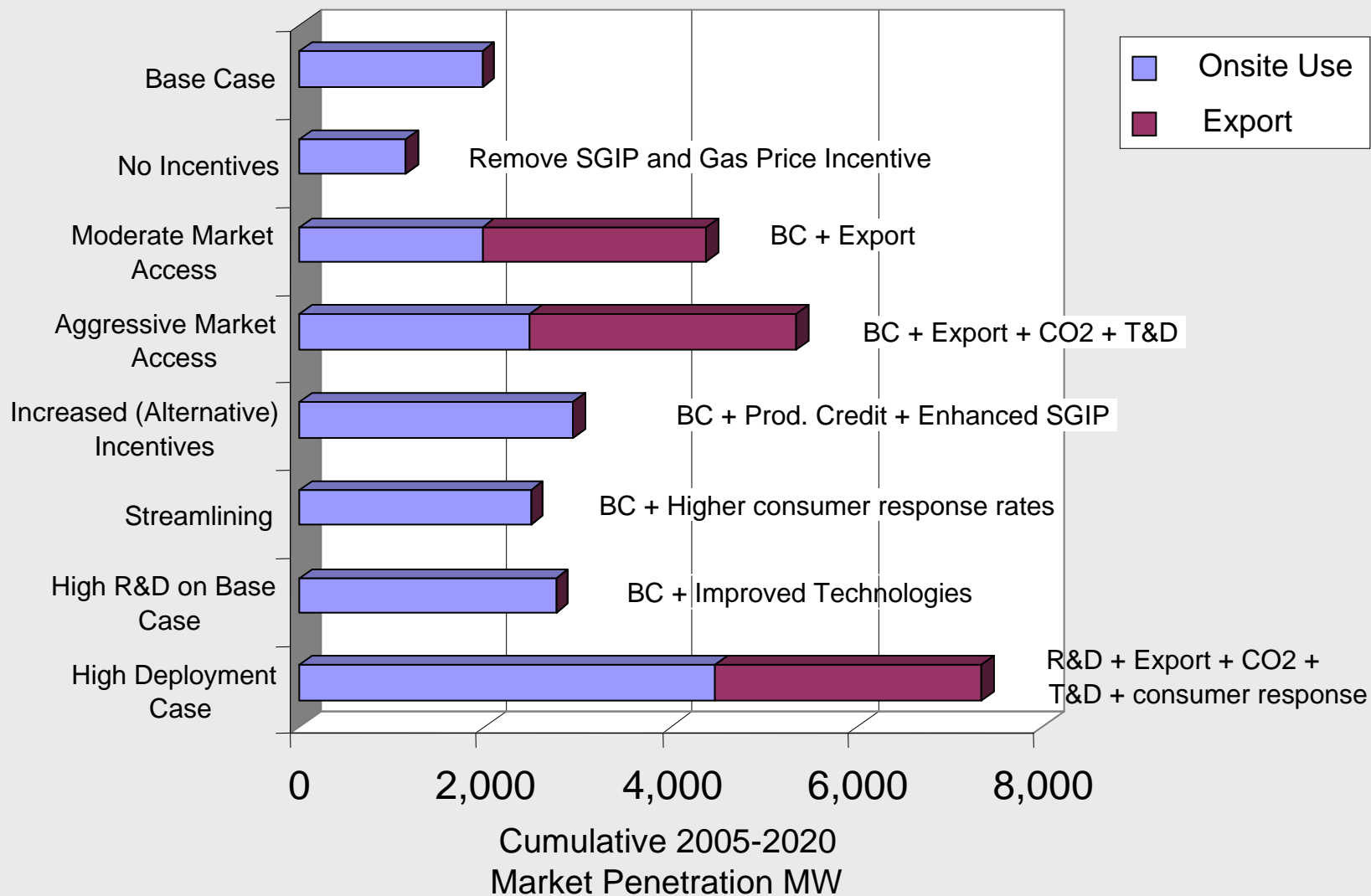


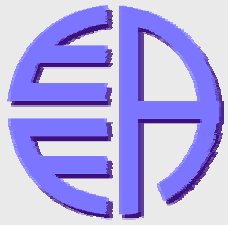
Alternative Scenarios Considered

- Removal of existing CHP incentives
- Addition of a number of policy incentives
 - Facilitation of export market
 - Payment for CO₂ reduction
 - Utility payment for T&D support
 - CHP production credit
 - Expanded SGIP eligibility
- More rapid improvement in CHP technology
- Increase in consumer confidence and project risk/payback acceptance



Scenario Factors and Results





More Information

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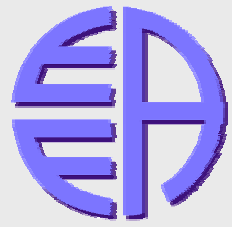
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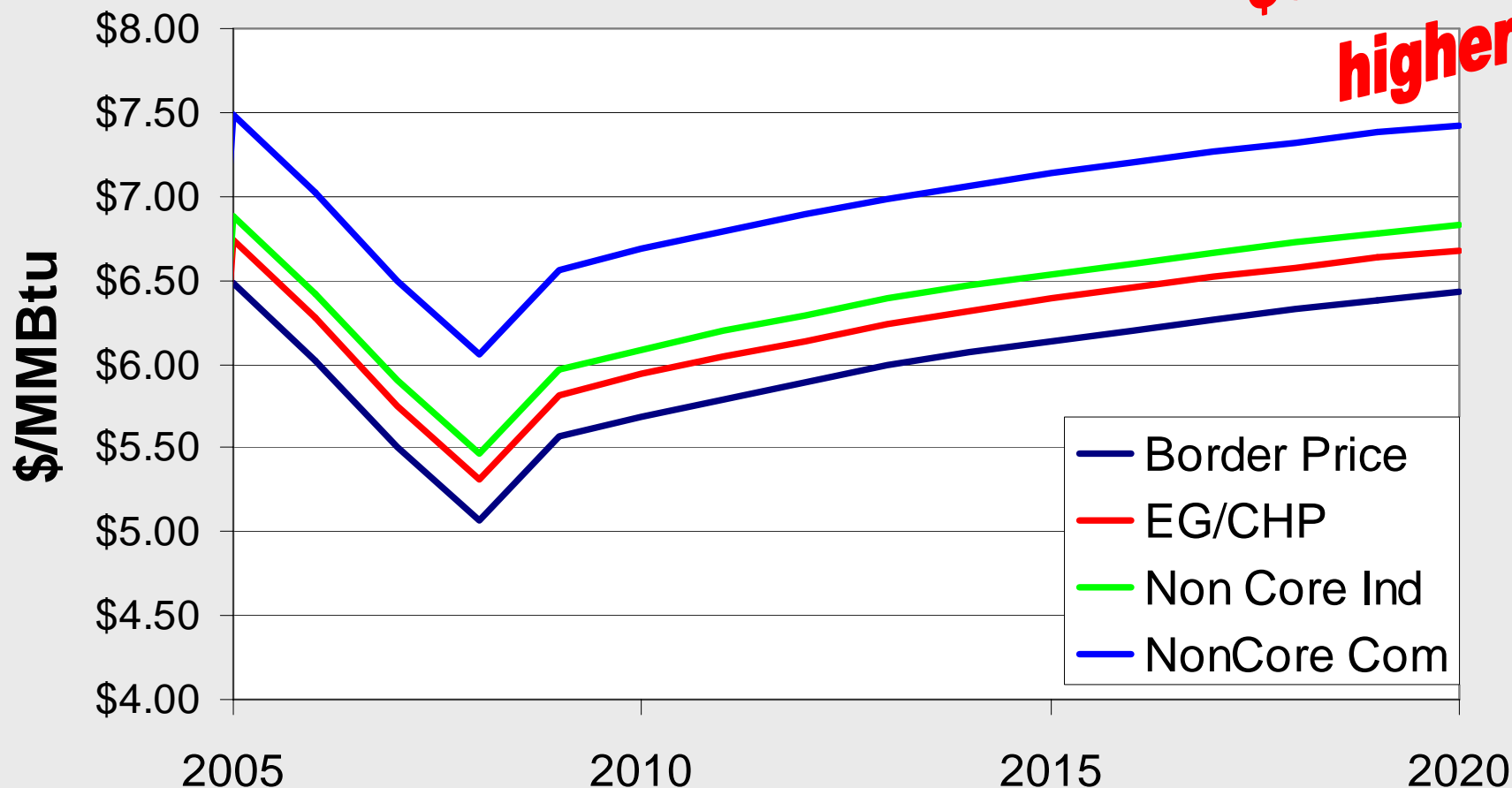


Appendix: Supplementary Information



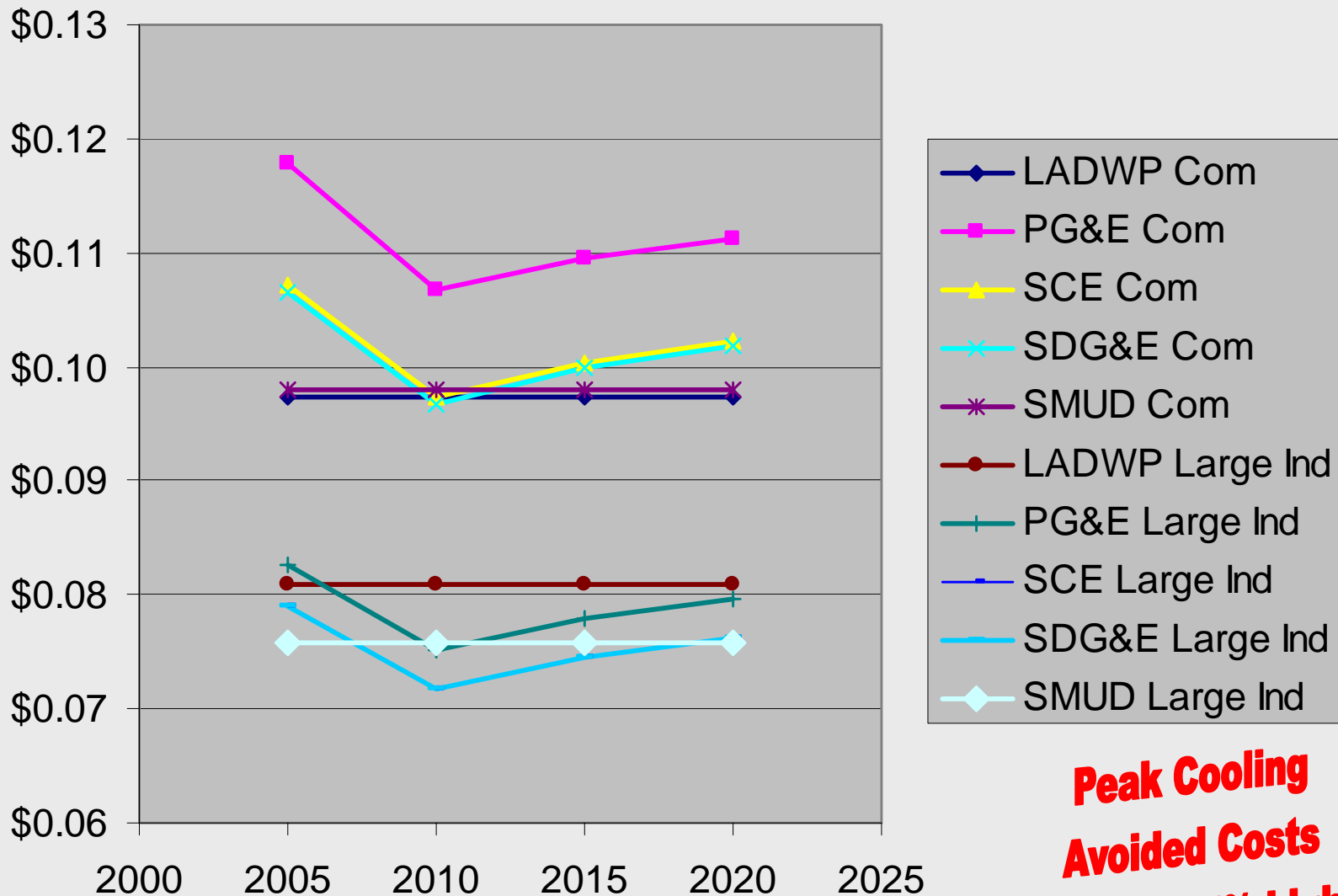
Natural Gas Price Forecast North Region 2005 Constant Dollars

**South prices
\$0.45/MMBtu
higher**





Range of Retail Electric Rate Forecasts (\$2005/kWh)

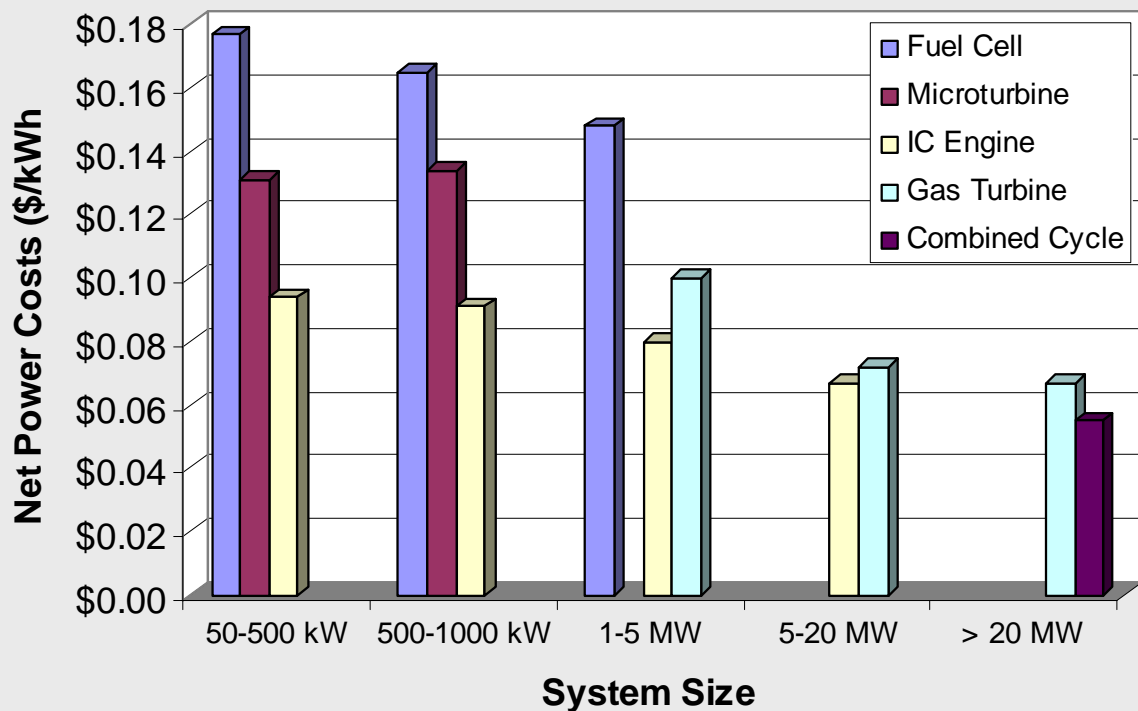


**Peak Cooling
Avoided Costs
125% to 205% higher**



CHP Technology Assumptions

**2010 Net Power Costs -- PG&E
(without SGIP Incentives or R&D)**



- Recip. Engine lowest cost small CHP technology
- Gas Turbine lowest cost large CHP technology
- Emerging Technologies
 - fuel cells and microturbines
 - early market costs not competitive
- Cost reductions assumed in later years
- Detailed technology cost and performance assumptions provided

Net Power Costs = (Amortized Capital + Fuel Costs + O&M – Avoided Boiler Fuel Costs)/Annual Elec. Output



Phased Emissions Standards

Technology	Exempt (1298) (< 50 hp)	BACT (up to 50 MW)			> 50 MW
		Bay Area	South Coast	San Joaquin	
2003 Standards					
Gas Turbines	0.5 lbs/MWh (9 ppm)	9 ppm, < 2 MW 5 ppm, 2 to 40 MW	9 ppm, < 3 MW 2.5 ppm, 2 to 50 MW	9 ppm, < 3 MW 2.5 ppm, 2 to 50 MW	2.5 ppm
Recip Engines	0.5 lbs/MWh (0.15 gm/bhphr)	0.15 gm/bhphr	0.15 gm/bhphr	0.15 gm/bhphr	N/A
2007 Standards					
Gas Turbines	0.07 lbs/MWh (1.5 ppm)	9 ppm, < 2 MW 5 ppm, 2 to 40 MW	0.07 lbs/MWh	9 ppm, < 3 MW 2.5 ppm, 2 to 50 MW	2.5 ppm
Recip Engines	0.07 lbs/MWh (0.022 gm/bhphr)	0.15 gm/bhphr	0.07 lbs/MWh	0.15 gm/bhphr	N/A

- 2007 standards assumed to be implemented immediately in the South
- Reciprocating engines and small turbines are not able to meet the 2007 South Coast standard until 2010 based on assumed technology improvements (base case) – eliminating market penetration until 2010
- South Coast standards are not assumed to be adopted in the North